

# Stanford

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## Bernard Roth

Rodney H. Adams Professor in the School of Engineering  
Mechanical Engineering

### Bio

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#### BIO

Roth is one of the founders of the Hasso Plattner Institute of Design at Stanford (the d.school) and is active in its development: currently, he serves as Academic Director. His design interests include organizing and presenting workshops on creativity, group interactions, and the problem solving process. Formerly he researched the kinematics, dynamics, control, and design of computer controlled mechanical devices. In kinematics, he studied the mathematical theory of rigid body motions and its application to the design of machines.

#### ACADEMIC APPOINTMENTS

- Professor, Mechanical Engineering
- Member, Child Health Research Institute

#### HONORS AND AWARDS

- Outstanding Design Educator Award, ASME (2000)
- Pioneer in Robotics Award, IEEE (2000)
- Honorary Professor, Design Program, IIT-Kanpur, India
- Honorary Diploma, Engineering Mechanics, National Technical University of Ukraine (2003)
- Honoris Causa degree, University of Cassino, Italy (2005)
- Honorary Co-chair, International Conference on Robotics and Automation (2007)
- Honorary PhD, University of Paris (Pierre & Marie Curie) (2007)

#### PROFESSIONAL EDUCATION

- PhD, Columbia , Mechanical Engineering (1963)

### Teaching

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#### COURSES

##### 2017-18

- Kinematic Synthesis of Mechanisms: ME 322 (Win)
- Mechanical Engineering Design: ME 113 (Spr)
- The Designer in Society: ME 315 (Win)
- Transformative Design: ENGR 231 (Aut)

##### 2016-17

- Advanced Kinematics: ME 330 (Win)
- Mechanical Engineering Design: ME 113 (Spr)
- The Designer in Society: ME 315 (Win)
- Transformative Design: ENGR 231 (Aut)

#### 2015-16

- Kinematic Synthesis of Mechanisms: ME 322 (Win)
- The Designer in Society: ME 315 (Win)
- Transformative Design: ENGR 231 (Aut)

#### 2014-15

- Advanced Kinematics: ME 330 (Win)
- Educating Young STEM Thinkers: EDUC 139X, EDUC 239X, ME 139, ME 231 (Win, Spr)
- The Designer in Society: ME 315 (Win)

## STANFORD ADVISEES

### Master's Program Advisor

Yunjae Hwang, Marion Lepert

## Publications

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### PUBLICATIONS

- **Multi-Degree-of-Freedom Mechanical Systems**  
Roth, B.
- **Measures of Error in Linkage Synthesis** *ibid*  
Roth, B., Gupta, K., C.  
: 861-866
- **Algebraic Line Symmetric Motions** *ibid*  
Roth, B., Ravani, B.  
: 1287-1290
- **Kinematics of a Hybrid Series-Parallel Manipulator System, Part I: Position Kinematics** *ibid*  
Roth, B., Waldron, K., J., Raghavan, M.  
: 127-136
- **Visualising professional vision interactions in design reviews** *CODESIGN-INTERNATIONAL JOURNAL OF COCREATION IN DESIGN AND THE ARTS*  
Sonalkar, N., Mabogunje, A., Leifer, L., Roth, B.  
2016; 12 (1-2): 73-92
- **On the advantages of instantaneous invariants and geometric kinematics** *MECHANISM AND MACHINE THEORY*  
Roth, B.  
2015; 89: 5-13
- **Acting with Creative Confidence: Developing a Creative Agency Assessment Tool** *Design Thinking Research: Measuring Performance in Context.*  
Royalty, A., Oishi, L., Roth, B.  
edited by Plattner, H., Meinel, C., Leifer, L.  
Springer Verlag.2013
- **I Use It Every Day: Pathways to Adaptive Innovation After Graduate Study in Design Thinking** *Design Thinking Research: Measuring Performance in Context.*  
Royalty, A., Oishi, L., Roth, B.

- 
- edited by Plattner, H., Meinel, C., Leifer, L.  
Springer Verlag.2012: 95–105
- **Assessing d.learning: Capturing the Journey of Becoming a Design Thinker** *Design Thinking Research: Measuring Performance in Context.*  
Goldman, S., Carroll, Maureen, P., Kabayadondo, Z., Cavagnaro, L. B., Royalty, Adam, W., Roth, B.  
edited by Plattner, H., Meinel, C., Leifer, L.  
Springer Verlag.2012: 13–34
  - **Ferdinand Freudenstein** *Indian Academy of Sciences, Bangalore, India*  
Roth, B.  
2010; 15 (8): 690-698
  - **Navigating the Barriers to Interdisciplinary Design Education: Lessons Learned from the NSF Design Workshop Series**  
Roth, B., Simpson et al, Timothy, W.  
2010
  - **Large workspace haptic devices - A new actuation approach** *16th Symposium on Haptics Interfaces for Virtual Environment and Teleoperator Systems*  
Zinn, M., Khatib, O., Roth, B., Salisbury, J. K.  
IEEE COMPUTER SOC.2008: 185–192
  - **Forward** *Springer Handbook of Robotics*  
Roth, B.  
edited by Siciliano, B., Khatib, O.  
Springer.2008: v-ix
  - **In Memory of Professor Ferdinand Freudenstein, 1926–2006** *Journal of Mechanical Design*  
Roth, B.  
2007; 129: 241-2
  - **Design Thinking** *Science of Machines (in Japanese)*  
Roth, B.  
2007; 59 (1): 149-154
  - **Ferdinand Freudenstein** *Distinguished Figures in Mechanism and Machine Science: Their Contributions and Legacies*  
Roth, B.  
edited by Ceccarelli, M.  
Springer Verlag, Berlin.2007: 151–181
  - **Advances in Robot Kinematics, Mechanisms and Motion**  
Roth, B.  
edited by Lenarcic, J., Roth, B.  
Springer, Dordrecht, The Netherlands.2006
  - **Design Thinking**  
Roth, B.  
2006
  - **Finding geometric invariants from time-based invariants for spherical and spatial motions** *JOURNAL OF MECHANICAL DESIGN*  
Roth, B.  
2005; 127 (2): 227-231
  - **Design Projects** *Design News, IIT Kanpur*  
Roth, B.  
2005
  - **Playing it safe** *IEEE ROBOTICS & AUTOMATION MAGAZINE*  
Zinn, M., Khatib, O., Roth, B., Salisbury, J. K.  
2004; 11 (2): 12-21
  - **A new actuation approach for human friendly robot design** *8th International Symposium on Experimental Robotics (ISER 02)*

Zinn, M., Roth, B., Khatib, O., Salisbury, J. K.  
SAGE PUBLICATIONS LTD.2004: 379–98

● **Advances in Creative Engineering and Education**

Roth, B., Roth, B.  
2004

● **A new actuation approach for human friendly robot design** *IEEE International Conference on Robotics and Automation*

Zinn, M., Khatib, O., Roth, B.  
IEEE.2004: 249–254

● **Time-invariant properties of planar motions** *9th International Symposium on Advances in Robot Kinematics*

Roth, B.  
SPRINGER.2004: 79–88

● **Actuation Methods for Human-centered Robotics and Associated Control Challenges** *Control Problems in Robotics*

Zinn, M., Khatib, O., Roth, B., Salisbury, K.  
edited by Bicchi, A., Christensen, H., Pratticizzo, D.  
Springer Tracts in Advanced Robotics.2003

● **A new actuation approach for human friendly robot design** *8th International Symposium on Experimental Robotics (ISER 02)*

Zinn, M., Khatib, O., Roth, B., Salisbury, J. K.  
SPRINGER-VERLAG BERLIN.2003: 113–122

● **Actuation methods for human-centered robotics and associated control challenges** *2nd International Workshop on Control Problems in Robotics and Automation*

Zinn, M., Khatib, O., Roth, B., Salisbury, J. K.  
SPRINGER-VERLAG BERLIN.2003: 105–119

● **New Exciting Ideas in Old Areas**

Roth, B.  
2003

● **Toward a Human-centered Intrinsically Safe Robotic Manipulator**

Zinn, M., Khatib, O., Roth, B., Salisbury, K.  
2002

● **A New Actuation Approach for Human Friendly Robot Design**

Zinn, M., Khatib, O., Roth, B., Salisbury, J., Kenneth  
2002

● **The Major Solved and Open Problems in the Design of Mechanisms and Robots**

edited by Bhattacharyya, R., Mohanty, A., R., Karagpur, I.I., T.  
2001

● **The Theoretical Basis for the Mechanical Aspects of Robot Design**

Roth, B.  
edited by Morecki, A., Bianchi, G., Rzymkowski, C.  
2001

● **The Search for the Fundamental Principles of Mechanism Design**

Roth, B.  
edited by Ceccerelli, M.  
2000

● **IFToMM from a Personal Perspective**

Roth, B.  
edited by Ceccerelli, M.  
2000

- **On the kinematic analysis of robotic mechanisms** *INTERNATIONAL JOURNAL OF ROBOTICS RESEARCH*  
Nielsen, J., Roth, B.  
1999; 18 (12): 1147-1160
- **Solving the input output problem for planar mechanisms** *JOURNAL OF MECHANICAL DESIGN*  
Nielsen, J., Roth, B.  
1999; 121 (2): 206-211
- **In-parallel manipulators: A framework on how to model actuation schemes and a study of their effects on singular postures** *JOURNAL OF MECHANICAL DESIGN*  
Matone, R., Roth, B.  
1999; 121 (1): 2-8
- **Second Order Approximations for Ruled-Surface Trajectories**  
Roth, B.  
1999
- **Chebyshev Approximation Methods for Evaluating Conicity** *Measurement*  
Roth, B., Chatterjee, G.  
1998; 23: 63-76
- **Formulation and solution for the direct and inverse kinematics problems for mechanisms and mechatronics systems** *Conference of the NATO Advanced Study Institute on Computational Methods in Mechanisms*  
Nielsen, J., Roth, B.  
SPRINGER-VERLAG BERLIN.1998: 33–52
- **Manufacturing**  
Roth, B.  
edited by Shirai, Y., Hirose, S.  
1998
- **The Effects of Actuation Schemes on the Dynamic Performance of Serial Manipulators**  
Roth, B., Matone, R.  
1998
- **Formulation and Solution for the Direct and Inverse Kinematics Problems for Mechanism and Mechatronic Systems** *Computational Methods in Mechanical Systems*  
Roth, B., Nielsen, J.  
edited by Angeles, J., Zakhariiev, E.  
Springer.1998: 33–52
- **On Chebyshev fits for pairs of lines and polygons with specified internal angles** *PRECISION ENGINEERING-JOURNAL OF THE INTERNATIONAL SOCIETIES FOR PRECISION ENGINEERING AND NANOTECHNOLOGY*  
Chatterjee, G., Roth, B.  
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- **The effects of actuation schemes on the kinematic performance of manipulators** *JOURNAL OF MECHANICAL DESIGN*  
Matone, R., Roth, B.  
1997; 119 (2): 212-217
- **Connectivity in open and closed loop robotic mechanisms** *MECHANISM AND MACHINE THEORY*  
Shoham, M., Roth, B.  
1997; 32 (3): 279-294
- **The Design of Projects and Contests — The Rules of the Game**  
Faste, R., Roth, B.  
1997
- **Sine–Cosine Polynomial Systems**  
Roth, B., Nielsen, J.

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edited by Giralt, G., Herzinger, G.  
1996

- **The direct kinematics of the general 6-5 Stewart-Gough mechanism** *5th International Symposium on Advances in Robot Kinematics*  
Nielsen, J., Roth, B.  
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- **On the Geometry of Spatial Polygons and Screw Polygons**  
Roth, B., Mavroidis, C.  
edited by McCarthy, J., Michael  
1996, 1997
- **Designing Manipulators for Both Kinematic and Dynamic Isotropic Properties**  
Roth, B., Matone, R.  
edited by Morecki et al, A.  
1996
- **The Direct Kinematics of the General 6–5 Stewart–Gough Mechanism** *Recent Advances in Robot Kinematics*  
Roth, B., Nielsen, J.  
edited by Lenarcic, J., Parenti-Castelli, V.  
Kluwer Academic Publishers, Dordrecht.1996: 7–16
- **New and Revised Overconstrained Mechanisms** *J. of Mechanical Design, Trans. ASME*  
Roth, B., Mavroidis, C.  
1995; 117: 75-80
- **Solving Polynomial Systems for the Kinematic Analysis and Synthesis of Mechanisms and Robot Manipulators** *Special 50th Anniversary Design Issue, J. of Mechanical Design and J. of Vibration and Acoustics, Trans. ASME*  
Roth, B., Raghavan, M.  
1995; 117(B): 71-79
- **Elimination Methods for Spatial Synthesis Problems**  
Roth, B., Nielsen, J.  
1995
- **Analysis of Singular Configurations of Manipulators and Mechanisms**  
Roth, B., Mavroidis, C.  
1995
- **Analysis of Overconstrained Mechanisms** *J. of Mechanical Design, Trans. ASME*  
Roth, B., Mechanisms, C.  
1995; 117: 69-74
- **How Can Robots Look Like Human Beings**  
Roth, B.  
1995
- **POSITION-FORCE SYNTHESIS OF CLOSED-LOOP LINKAGES** *JOURNAL OF MECHANICAL DESIGN*  
Huang, C., Roth, B.  
1994; 116 (1): 155-162
- **A UNIFIED THEORY FOR KINEMATIC SYNTHESIS** *JOURNAL OF MECHANICAL DESIGN*  
James, P. A., Roth, B.  
1994; 116 (1): 144-154
- **ANALYTIC EXPRESSIONS FOR THE FINITE SCREW SYSTEMS** *MECHANISM AND MACHINE THEORY*  
Huang, C., Roth, B.  
1994; 29 (2): 207-222
- **Experiential Design in Engineering Education**

- Roth, B., Wilde, D., J., Faste, R.  
edited by Tornkvist, S.  
1994
- **Computational Advances in Robot Kinematics** *Advances in Robot Kinematics and Computational Geometry*  
Roth, B.  
edited by Lenarcic, J., Ravani, B.  
Kluwer Academic Publishers, Dordrecht.1994: 7–16
  - **Analysis and Synthesis of Overconstrained Mechanisms** *Mechanism Synthesis and Analysis*  
Roth, B., Mavroidis, C.  
edited by Pennock, G.  
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  - **A UNIFIED THEORY FOR FINITE, INFINITESIMAL, AND HYBRID KINEMATIC SYNTHESIS** *JOURNAL OF MECHANICAL DESIGN*  
James, P. A., Roth, B.  
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  - **INVERSE KINEMATICS OF THE GENERAL 6R-MANIPULATOR AND RELATED LINKAGES** *JOURNAL OF MECHANICAL DESIGN*  
Raghavan, M., Roth, B.  
1993; 115 (3): 502-508
  - **PRODUCTION AND CHARACTERIZATION OF A SPECIFIC 5-HT(2) RECEPTOR ANTIBODY** *BRAIN RESEARCH*  
Garlow, S. J., Morilak, D. A., Dean, R. R., Roth, B. L., CIARANELLO, R. D.  
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  - **DIMENSIONAL SYNTHESIS OF CLOSED-LOOP LINKAGES TO MATCH FORCE AND POSITION SPECIFICATIONS** *JOURNAL OF MECHANICAL DESIGN*  
Huang, C., Roth, B.  
1993; 115 (2): 194-198
  - **Integrating Creativity into the Mechanical Engineering Curriculum** *Innovations in Engineering Design Education, ASME*  
Roth, B., Faste, R., A., Wilde, D., J.  
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  - **Best Placement of Telescoping Robots in Environments with Obstacles**  
Roth, B., Kolorov, K.  
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  - **The Synthesis of Spatial Linkages** *Section 5.4 in Modern Kinematics: Developments in the Last Forty Years*  
Roth, B., Bodduluri et al, M.  
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  - **New Manipulators with Simple Inverse Kinematics**  
Roth, B., Mavroidis, C.  
edited by Morecki, A., Bianchi, G., Jaworek, K.  
1993
  - **A Closed-Form Solution of the Forward Displacement Analysis of a Class of In-Parallel Mechanisms**  
Roth, B., Lee, H., Y.  
1993
  - **Robotics Research, The Sixth International Symposium PA**  
Roth, B.  
edited by Kanada, T., Valley, H.  
1993
  - **Computations in Kinematics** *Computational Kinematic*  
Roth, B.

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edited by Angeles, J., Homel, J., Kovacs, P.

Kluwer Academic Publishers, Dordrecht.1993: 3–14

- **STATICS OF IN-PARALLEL MANIPULATOR SYSTEMS** *DESIGN TECHNICAL CONF*  
AGRAWAL, S. K., Roth, B.  
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- **BINDING OF TYPICAL AND ATYPICAL ANTIPSYCHOTIC AGENTS TO TRANSIENTLY EXPRESSED 5-HT1C RECEPTORS** *JOURNAL OF PHARMACOLOGY AND EXPERIMENTAL THERAPEUTICS*  
Roth, B. L., CIARANELLO, R. D., Meltzer, H. Y.  
1992; 260 (3): 1361-1365
- **Structural Parameters which Reduce the Number of Manipulator Configuration** *Robotics, Spatial Mechanisms and Mechanical Systems, also in J. of Mechanical Design, Trans. ASME*  
Roth, B., Mavroidis, C.  
1992, 1994; 45, 116: 359-366, 3-10
- **Best Estimates for the Construction of Robots in Environments with Obstacles**  
Roth, B., Kolarov, K.  
1992
- **CHRONIC MIANSERIN TREATMENT DECREASES 5-HT2 RECEPTOR-BINDING WITHOUT ALTERING 5-HT2 RECEPTOR MESSENGER-RNA LEVELS** *EUROPEAN JOURNAL OF PHARMACOLOGY-MOLECULAR PHARMACOLOGY SECTION*  
Roth, B. L., CIARANELLO, R. D.  
1991; 207 (2): 169-172
- **DEVELOPMENTAL REGULATION OF 5-HT2 AND 5-HT1C MESSENGER-RNA AND RECEPTOR LEVELS** *DEVELOPMENTAL BRAIN RESEARCH*  
Roth, B. L., Hamblin, M. W., CIARANELLO, R. D.  
1991; 58 (1): 51-58
- **New Robot Mechanisms for Robot Capabilities**  
Roth, B., Khatib, O.  
1991
- **On the Number of Links and Placement of Telescoping Manipulators in an Environment with Obstacles**  
Roth, B., Kolarov, K.  
1991
- **A General Solution of the Inverse Kinematics of All Series Chains**  
Roth, B., Raghavan, M.  
1991
- **The Design of a High-Performance Force-Controlled Manipulator**  
Roth, B., Khatib, O., Waldron, K., J.  
1991
- **REGULATION OF 5-HT2 AND 5-HT1C SEROTONIN RECEPTOR LEVELS - METHODOLOGY AND MECHANISMS** *SATELLITE WORKSHOP OF THE AMERICAN COLLEGE OF NEUROPSYCHOPHARMACOLOGY: SUBTYPES OF RECEPTORS FOR SEROTONIN AND THEIR EFFECTORS*  
Roth, B. L., Hamblin, M., CIARANELLO, R. D.  
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- **The Moral Arguments Against Military Research** *Ethical Issues Associated with Scientific and Technological Research for the Military*  
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- **Kinematic Analysis of the 6R Manipulator of General Geometry** *Robotics Research, The of Fifth International Symposium*  
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- **A Unified Theory of Finite, Infinitesimal and Hybrid Kinematic Synthesis** *Mechanism Synthesis and Analysis, DE-Vol. 25, ASME 1990, pp. 461-469; also in J. of Mechanical Design, Trans. ASME*  
Roth, B., James, P.  
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- **THE MORAL ARGUMENTS AGAINST MILITARY RESEARCH** *ANNALS OF THE NEW YORK ACADEMY OF SCIENCES*  
Roth, B.  
1989; 577: 21-33
- **Kinematics of a Hybrid Series-Parallel Manipulation System** *JOURNAL OF DYNAMIC SYSTEMS MEASUREMENT AND CONTROL-TRANSACTIONS OF THE ASME*  
Waldron, K. J., Raghavan, M., Roth, B.  
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- **CROSS-LINKING OF [I-125] BETA-ENDORPHIN TO MU-OPIOID RECEPTORS DURING DEVELOPMENT** *DEVELOPMENTAL BRAIN RESEARCH*  
McLean, S., Rothman, R. B., Chuang, D. M., Rice, K. C., Spain, J. W., Coscia, C. J., Roth, B. L.  
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- **RAT-BRAIN PROTEIN KINASE-C - PURIFICATION, ANTIBODY-PRODUCTION, AND QUANTIFICATION IN DISCRETE REGIONS OF HIPPOCAMPUS** *JOURNAL OF NEUROCHEMISTRY*  
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- **On the Design of Manipulators for Applying Wrenches**  
Roth, B., Raghavan, M.  
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- **Design and Kinematics for Force and Velocity Control of Manipulators and End-Effectors** *Ch. 12 of Robotics Science*  
Roth, B.  
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MIT Press.1989: 459-475
- **Position Errors Due to Clearance in Journal Bearings** *Transactions of the ASME, Journal of Mechanisms, Transmissions and Automation in Design*  
Roth, B., Wang, H., H.  
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- **A NEW APPROACH FOR KINEMATIC RESOLUTION OF REDUNDANCY** *INTERNATIONAL JOURNAL OF ROBOTICS RESEARCH*  
Ghosal, A., Roth, B.  
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- **New Approach for Kinematic Resolution of Redundancy** *The International Journal of Robotics Research*  
Roth, B., Ghosal, A.  
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- **Position Errors of Manipulators**  
Roth, B., Wang, H., H.  
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- **Kinematic Structure for a Force Controlled Redundant Manipulator**  
Roth, B., Raghavan, M., Khatib, O., Waldron, K., J.  
1988
- **Lessons from Abroad for Educators in the USA - Some Personal Views and Perspectives** *Mechanical Engineering News*  
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- **On the Spatial Motion of a Rigid Body with Line Contact**  
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- **Direct Computation of Grasping Force for Three-Finger Tip Prehension Grasps** *Transactions of the ASME, Journal of Mechanisms, Transmissions and Automation in Design*  
Roth, B., Ji, Z.  
1988; 110: 405-413
- **INSTANTANEOUS PROPERTIES OF MULTI-DEGREES-OF-FREEDOM MOTIONS - POINT TRAJECTORIES** *JOURNAL OF MECHANISMS TRANSMISSIONS AND AUTOMATION IN DESIGN-TRANSACTIONS OF THE ASME*  
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- **INSTANTANEOUS PROPERTIES OF MULTI-DEGREES-OF-FREEDOM MOTIONS - LINE TRAJECTORIES** *JOURNAL OF MECHANISMS TRANSMISSIONS AND AUTOMATION IN DESIGN-TRANSACTIONS OF THE ASME*  
Ghosal, A., Roth, B.  
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- **Robots and the Military: Do They Really Need Each Other?** *The CPSR Newsletter, v. 5, no. 3, 1987, pp. 1-8. Robotic Research, The Fourth International Symposium*  
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- **of a Hybrid Series-Parallel Manipulator System, Part II: Rate and Force Decomposition**  
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1987
- **On the Spatial Motion of a Rigid Body with Point Contact**  
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- **Contact Force in Grasping and Kinematic Constraints**  
Roth, B., Ji, Z.  
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- **Impact Sensitivity to Mass Distribution of a Planar Manipulator**  
Roth, B., Cai, C.  
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- **Analytic Design of Two-Revolute Open Chains**  
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- **WORKSPACE AND MOBILITY OF A CLOSED-LOOP MANIPULATOR** *INTERNATIONAL JOURNAL OF ROBOTICS RESEARCH*  
Bajpai, A., Roth, B.  
1986; 5 (2): 131-142
- **ON THE PLANAR MOTION OF RIGID BODIES WITH POINT CONTACT** *MECHANISM AND MACHINE THEORY*  
Cai, C. S., Roth, B.  
1986; 21 (6): 453-466
- **Analytic Design of Open Chains**  
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1986
- **Special Grasping Configurations with Dexterous Hands**  
Roth, B., Kerr, J.  
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- Roth, B.  
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- **ANALYSIS OF MULTIFINGERED HANDS** *INTERNATIONAL JOURNAL OF ROBOTICS RESEARCH*  
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  - **SYNTHESIS OF CONTROL-SYSTEMS FOR MANIPULATORS USING MULTIVARIABLE ROBUST SERVOMECHANISM THEORY** *INTERNATIONAL JOURNAL OF ROBOTICS RESEARCH*  
Desa, S., Roth, B.  
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  - **R&D Issues in Contact Sensing**  
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  - **Overview on Advanced Robotics: Manipulation**  
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1985
  - **Mechanics: Kinematics and Dynamics** *Recent Advances in Robotics*  
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  - **On the Optimal Selection and Placement of Manipulators** *Theory and Practice of Robots and Manipulators*  
Roth, B., Scheinman, V.  
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  - **Control and Mechanics of Simple Manipulator Systems**  
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